ACUTE EFFECTS OF BAREFOOT TRAINING ON LEG POWER PRODUCTION AND METABOLICS IN A MILITARY POPULATION

Aaron Phelps and Kyle Terhark

Department of Human Kinetics and Applied Health Sciences

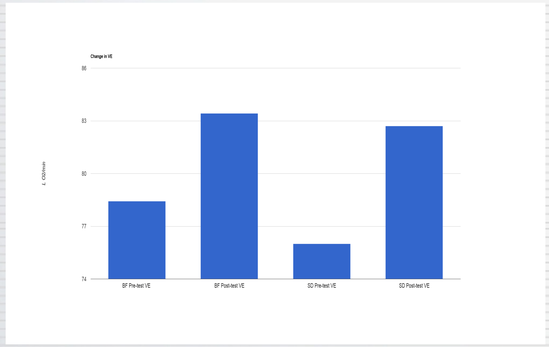
The Biokinetics Program

Abstract

PURPOSE: The purpose of this study was to identify any relation between barefoot training and leg power production as well as running economy, in order to determine if this training increases athletic performance substantially over normal shod training.
METHODS: 14 Male participants (age 21±1 year) were recruited from the University of Minnesota Army ROTC program. The participants were split into an experimental (n=7) and a control group (n=7). The experimental group received barefoot training, while the control group received normal shod training. Pre- and post-testing consisted of a half squat profile (HS Profile), countermovement jump test (CMJ), plyometric jump test (Plyo), and a metabolics test up to 85% of predicted HRmax. A 3D accelerometer (Myotest, Switzerland) was utilized to record power, force, velocity, and ground reaction force. In between testing, the subjects trained 3 days a week for 4 weeks on lower body power/strength, interval run training, and jump training.
RESULTS: Repeated independent t-tests were performed to determine significance ($p \leq 0.05$) between the control and experimental groups. Variables measured were 85% VO2 max (mLO2/kg · min-1), pulmonary ventilation (VE), HS profile power max (W), plyo contact time (ms), stiffness (kN/m), CMJ max power (W), CMJ CON/ECC power ratio (W), and CMJ max height (cm). All variables tested yielded no significance between pre- and post-test results for either group, except for CMJ max height ($p=0.050$), in which the barefoot group showed significantly less improvement than the shod group.
CONCLUSION: Metabolic and leg power production results revealed that there was no significant difference between the barefoot and shod groups in all variables except CMJ max height. The barefoot training group experienced no change in max height while the shod training group slightly increased. This study provided evidence that acute barefoot training does not significantly affect overall athletic performance.

Introduction

Within the last 5-10 years, the idea of barefoot running has exploded in the world of running and has begun to influence the casual runner as well. The concept has become increasingly popular as runners continue to identify what they believe are problems with shod running, mainly the notion that modern running shoes force the runner to adopt a heel-strike pattern which causes overwhelming stress on the lower leg bones and joints (9). The United States Army is experiencing this firsthand in its basic training, as one of the leading causes of injury for female soldiers is hip fracture, assumed to be caused by high amounts of running and carrying heavy loads. Many researchers and barefoot runners would infer that the increase in stress fractures in the tibia and hip amongst runners is caused by the forced heel-strike running pattern. Proponents of barefoot running argue that the lack of foot protection does not promote further injury, but may actually help prevent injury by promoting a mid-foot strike pattern that disperses the force of the impact instead of centralizing the impact on the bones and joints of the lower leg. (10). It has also been suggested that barefoot training increases performance and economy of running. Because of the increasing popularity of barefoot running/training and the claims made by its proponents, it is important to understand the effects of this type of training The purpose of this study is to identify any correlations between barefoot training and our tested variables, in order to determine if this training increases athletic performance substantially over normal shod training.



Methods

14 Male cadets from the University of Minnesota Twin-Cities Army ROTC program were recruited to participate in this study. Two groups of 7 subjects were established, the experimental group receiving barefoot training and the control group receiving shod training. Several pre-tests were conducted including a metabolics test (Oxycon mobile) up to 85% of predicted max heart rate, a half-squat profile, a countermovement jump, and a plyometric jump test. The subjects wore their regular athletic footwear during testing. A 3D accelerometer (Myotest, Switzerland) was utilized to record power, force, velocity, and ground reaction force. After pre-testing, the subjects underwent the 4-week training program. Subjects were trained 3 days a week using high-intensity and run interval training that in part mimicked how subjects had been trained using military physical fitness training. Training also included countermovement and plyometric jump training, box training, and various Olympic lifting protocols. The experimental group conducted all training barefoot, while the control group remained shod. Post-testing was conducted after the 4-week training period. Statistics were collected using SPSS analytic software [This sentence needs specificity, either explain or move to results].

Results

Repeated independent t-test were performed utilizing the SPSS statistical analysis software
VE Ventilatory Equivalence showed no statistically significant change (p=0.66)
HS Profile Power Max showed no statistically significant change (p=0.651)
Plyometric Contact Time showed no statistically significant change (p=0.93)
Stiffness showed no statistically significant change (p=0.15)
CMJ Max Power showed no statistically significant change (p=0.95)
CMJ CON/ECC Power Ratio showed no statistically significant change (p=0.63)
CMJ Max Height showed a statistically significant change (p=0.047)

Conclusion

After the 4 week training program, only CMJ max height showed a significant difference (p=0.047) between the two groups. Although the groups showed slight increases or decreases in the other variables tested, there was no other statistically significant differences between the experimental and control groups. There are several inferences that can be made from these findings. In regards to CMJ max height, which was used as a indicator of vertical jump height, the experimental group showed no change, while the control group improved significantly. One reason for this difference could be the psychological mindset of the athlete training barefoot and fearing injury from a lack of support and protection during jump and high-intensity training.
While other research has shown that barefoot training, and running in particular, can produce kinetic and biomechanical changes, it is important to understand that these changes take place over time. This research shows that there is little training value to training barefoot in an acute period of time. The lack of significant difference between the groups in both VE and 85% VO_2 max shows that in regards to efficiency of the body's utilization of O_2, barefoot training does not produce a significant advantage or disadvantage in an acute setting.
These researchers found little scientific research that studied the effects of barefoot training in a strength training setting, and therefore programmed this study to explore how the lack of footwear affected Olympic lifting and jump training. From what is known about the motor unit's response to training, the body's initial response to strength training comes in the form of increased innervation, recruitment, and synchronization of motor units in order to produce greater contractions.

References

Divert, C., Mornieux, G., Freychat, P., Baly, L., Mayer, F., & Belli, A. (2008). Barefoot-shod running differences: Shoe or mass effect? *International Journal of Sports Medicine, 29 (6), 512-518.*
Hanson, N., Berg, K., Deka, P., Meendering, J., & Ryan, C. (2011). Oxygen cost of running barefoot vs. running shod. *International Journal of Sports Medicine, 3*
Hardin, E. C., Van Den Bogert, A. J., & Hamill, J. (2004). Kinematic adaptations during running: Effects of footwear, surface, and duration. *Medicine & Science in Sports & Exercise, 36(5), 838.*
Jungers, W. L. (2010). Biomechanics: Barefoot running strikes back. *Nature, 463(7280), 433-434.*
Lieberman, D. E., Venkadesan, M., Werbel, W. A., Daoud, A. I., D'andrea, S., Davis, I. S., et al. (2010). Foot strike patterns and collision forces in habitually barefoot versus shod runners. *Nature, 463(7280), 531-535.*
Nigg, B. (2009). Biomechanical considerations on barefoot movement and barefoot shoe concepts. *Footwear Science, 1(2), 73-79.*
Scholz, M., Bobbert, M., Van Soest, A., Clark, J., & Van Heerden, J. (2008). Running biomechanics: Shorter heels, better economy. *Journal of Experimental Biology, 211(20), 3266.*
Squadrone, R., & Gallozzi, C. (2009). Biomechanical and physiological comparison of barefoot and two shod conditions in experienced barefoot runners. *Journal of Sports Medicine and Physical Fitness, 49(1), 6-13.*
Warburton, M. (2001). Barefoot running. *Sportscience, 5(3), 1-4.*
Zagatto, A. M., Beck, W. R., & Gobatto, C. A. (2009). Validity of the running anaerobic sprint test for assessing anaerobic power and predicting short-distance performances. *The Journal of Strength & Conditioning Research, 23(6), 1820.*

Acknowledgments

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Kyle Terhark: kjt42438@bethel.edu ▪ Aaron Phelps: akp25378@bethel.edu ▪ Seth Paradis: s-paradis@bethel.edu